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# Analysis of Students' mathematical problem-solving abilities

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***Abstract***

This study aims to analyze the mathematical problem-solving ability of grade VII students on ratio materials using Polya problem-solving steps. This study uses a qualitative descriptive approach involving 28 grade VII students of one of the State Junior High Schools in Sumedang Regency as participants. The instrument employed consisists of three descriptive test questions designed to assess students' abilities in understanding problems, planning solutions, executing those plans, and evaluating the outcomes of their problem-solving processes. The results of the study show that students with high abilities are able to solve each problem well, while students with agile skills experience difficulties at almost all stages, especially in understanding problems and developing solution plans. Mistakes that are often found in students with low ability include a lack of understanding of the concept of ratios and an inability to organize relevant information.
**Keywords:** Problem solving, math skills, grade VII students, Polya steps, math education

**Abstrak**

Penelitian ini bertujuan untuk menganalisis kemampuan pemecahan masalah matematis siswa kelas VII pada materi perbandingan dengan menggunakan langkah-langkah pemecahan masalah Polya. Penelitian ini menggunakan pendekatan deskriptif kualitatif dengan melibatkan 28 siswa kelas VII salah satu SMP Negeri di Kabupaten Sumedang sebagai partisipan. Instrumen yang digunakan terdiri dari tiga soal tes deskriptif yang dirancang untuk menilai kemampuan siswa dalam memahami masalah, merencanakan solusi, melaksanakan rencana tersebut, dan mengevaluasi hasil proses pemecahan masalah. Hasil penelitian menunjukkan bahwa siswa yang berkemampuan tinggi mampu menyelesaikan setiap permasalahan dengan baik, sedangkan siswa yang berkemampuan agile mengalami kesulitan pada hampir semua tahapan terutama dalam memahami permasalahan dan mengembangkan rencana penyelesaiannya. Kesalahan yang sering ditemukan pada siswa berkemampuan rendah antara lain kurangnya pemahaman konsep perbandingan dan ketidakmampuan mengorganisasikan informasi yang relevan.
**Kata Kunci**: Pemecahan masalah, kemampuan matematika, siswa kelas VII, langkah Polya, pendidikan matematika



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## INTRODUCTION

The primary objective of Law Number 20 of 2003 on the National Education System is to enchance the nation's intellectual capacity, nature students' potential, and buil character that aligns with Indonesia's cultural identity. National education is designed to produce individuals who have faith, piety, noble ethics, physical and spiritual health, knowledge, skills, independence, a sense of responsibility, and the spirit of nationalism (Law No. 20 of 2003). One of the subjects that contributes to the achievement of national education goals is mathematics, which is taught at every level of education. Etymologically, the term "mathematics" comes from the Greek, namely mathema or mathematics, which means things learned or knowledge learned (Hay et al., 2022). Mathematics plays an effective role as an effective tool to develop logical and systematic thinking skills. One of the main goals of mathematics learning is to improve problem-solving skills (Lestari & Rosdiana, 2018). This

skill represents a critical aspect of the mathematics learning process, both in the internal context of mathematics and its application in real life, science, and technology. Problem solving is described as the process of identifying and implementing solutions to address a challenge in order to attain the intended objectives.

In mathematics learning, problem solving has a central role and is the main focus. It has long been recognized as a significant aspect of mathematics, including its teaching and learning (Nlenur & Cordia, 2024). However, based on the PISA (Program for International Studies) study in the field of mathematics, around 71% of Indonesian students have not reached the minimum competency level. This shows that many students face difficulties in situations that require mathematical problem-solving skills (Wuryanto & Abdug, 2022)

As a fundamental component of the learning process, mathematical problem-solving provides students with the opportunity to develop skills and experience in solving various problems. The significance of problem-solving in mathematics positions it as a primary objective in instruction, as this skill is regarded as the essence of mathematics education. Thus, problem-solving skills are not only an important skill, but also a foundation that must be mastered by every individual who studies mathematics (Kurniawan et al., 2019).

Previous studies have shown that solving mathematical problems has significant challenges. Many students are unable to formulate appropriate strategies due to lack of skills in identifying relationships between data (Munawaroh et al 2023). The importance of evaluation in answers in improving problem-solving skills, but many students are not used to reviewing the results of their work (Fahira and Ramlah 2021).

Unlike the previous study, this study focuses specifically on the problem-solving ability of junior high school students on ratio material using polya steps. The novelty of this study is the use of specific indicators to measure each stage of problem-solving. Starting from understanding the problem to evaluating the results. Previous research, such as those conducted by Kurniawan et al. (2019), emphasizes the use of contextual problems without analyzing the problem-solving ability at each stage. Fitriyana and Sutirna (2022) are limited to the topic of the set without exploring other materials such as ratios.

In addition, other gaps are found in the methodology applied. Many previous studies have used a quantitative approach with less in-depth instruments and measured qualitative aspects of student ability. This study uses a qualitative descriptive approach specifically on grade VII students to provide a more comprehensive overview of the problem-solving process, which has not been explored much in previous studies.

Problem-solving skills are defined as the potential of students to solve or prove story problems and non-routine problems. These non-routine questions represent the competencies that students are required to master as a key objective of the learning process. Ability itself refers to a person's ability

or potential to master a skill, either as innate or as a result of practice or practice, which is manifested through individual actions (Fitria et al., 2018).

In solving mathematical problems, a systematic strategy or step is needed to overcome the obstacles faced. George Polya proposed four principles or steps in solving mathematical problems, namely: (1) Understanding the Problem, (2) developing a plan, (3) carrying out the plan, and (4) checking the results of the solution (Looking Back) (Rosita & Yuliawati, 2017). Indicators of problem-solving ability in this study include: (1) the ability to understand the problem, namely clearly identifying what is being asked in the problem; (2) the ability to identify relationships between data, both relevant and irrelevant, in order to get ideas and develop solution plans; (3) the ability to implement the settlement plan well; and (4) the ability to review the solutions obtained, including evaluating the results of the solution. This is important, especially for junior high school students, because at that age it is a phase of development of comprehension skills that are crucial in learning mathematics.

Based on this interpretation, researchers are encouraged to carry out research to measure the level of mathematical problem-solving ability in junior high school students by analyzing each relevant indicator. This research is expected to provide a comprehensive overview of students' problem-solving abilities and contribute significantly to the development of educational science, particularly within the domain of mathematics education

## METHOD

This research employs a descriptive method with a qualitative approach. The purpose of the descriptive method is to illustrate the mathematical problem-solving abilities of seventh-grade students on ratio material, based on the problem-solving stages outlined in Polya's theory. The study population includes 28 seventh-grade student from SMP negeri pamulihan, comprising 15 female and 13 male students.

The selection of research subjects is carried out by purposive sampling technique, which is a sample selection technique based on a specific purpose (Sugiyono, 2020). The research instrument is in the form of three description test questions designed to describe students' mathematical problem-solving skills. The material used is ratio material taught in the odd semester of grade VII in accordance with the Independent Curriculum. This test aims to evaluate students' ability to solve mathematical problems by applying the steps of Polya theory.

From the test results, six students were chosen as research subjects, representing three ability levels: two students with high abilities, two with moderate abilities, and two with low abilities. The students' responses to the descriptive test were examined based on Polya's problem-solving steps to evaluate their mathematical problem-solving skills on ratio material. The analysis utilized assessment interval to determine the students' achievement levels in solving problems according to the established indicators.

Table 1. Categories Assessment

| Value (%) | Capability Categories |
|---|---|
| 80.0 ≤ ≤ 100 | Tall |
| 60.0 ≤ ≤ 80.0 | Keep |
| < score 60.0 | Low |

(Buranda & Bernard, 2019)

## RESULTS AND DISCUSSION

This research was conducted by providing a problem-solving ability test on ratio material, which was designed based on the stages in Polya's steps. These stages include: (1) understanding the problem, (2) making a problem solving plan, (3) implementing the problem solving plan, and (4) evaluating or re-examining the results of the solution.

In the implementation of the research, six research subjects were obtained which were grouped into three categories, namely students with high, medium, and low abilities. Each category was represented by two research subjects. The selection of subjects is based on the test results of students who have gone through the correction process. Based on the assessment indicators listed in Table 1, the identification of the analyzed subjects is arranged based on the order of students' mathematical problem-solving ability test scores, starting from the highest score to the lowest score.

Table 2. List of Research Subjects Based on Test Result Scores

| It | Student | Value | Value Category |
|---|---|---|---|
| 1 | M1 | 90 | Tall |
| 2 | M2 | 86 | Tall |
| 3 | M3 | 75 | Keep |
| 4 | M4 | 65 | Keep |
| 5 | M5 | 55 | Low |
| 6 | M6 | 50 | Low |

The evaluation of students' answer indicated that they encountered several errors while attempting to solve athematical problems using Polya's problem-solving model.

1. Step 1: Understand the Problem

The analysis of the six selected research subjects revealed that several subjects continued to make errors during the problem comprehension stage. Subjects M6, M5, and M4 made a mistake in question number 2, where they did not write down information about what they knew or what was asked on the answer sheet. The students are unable to gather the information contained in the questions, and have difficulty describing statements based on known facts. This is reflected in their answers that only rewrite the questions without providing further explanations, showing that students do not understand the problem well. This error is mainly caused by students' lack of understanding of the concept of ratio material.

This result is in line with the findings of Hernaeny Ul'fah and Prastiwi (2021), which stated that in solving problems, students must understand the problem-solving process skillfully. This process includes the ability to select and identify relevant conditions and concepts, seek generalizations, formulate a solution plan, and organize pre-acquired skills.

Meanwhile, students with high ability categories are able to understand problems well. They demonstrate this ability through the presentation of information that is known in a complete and relevant manner according to the problem given. In contrast to students with medium ability, some of them are able to understand the problem partially by writing down known data. However, there are students in this category who do not record all known information or do not explicitly mention the problem in question. This shows that there is a variation in the level of student understanding at the stage of understanding the problem.

2. Step 2: Planning the Completion

During the second phase of problem-solving as outlined in Polya's theory, namely preparing a problem-solving plan, students are expected to be able to think and adjust the right strategy to achieve the right solution. At this stage, students should be able to apply the concepts, theories, and formulas they have learned before to solve problems. In this study, students who reached this stage included M1, M2, M3, and M4. However, they still made a mistake in question number 3. Meanwhile, M5 and M6 students still made mistakes in questions 1, 2, and 3. Mistakes that occur include the inability to write down strategies or plans that will be used to solve problems, as well as errors in understanding how to calculate ratios to solve a given problem.

This finding is in line with the opinion of Munawaroh et al. (2023), which stated that students often try to give answers to the given questions, but they do not really understand them, which leads to errors in the results of their completion. Suryani et al. (2020) also stated that in making a problem-solving plan, students need to look for relationships between the information provided and the unknown, which makes it possible to determine the right ratio.

Students who are in the high-ability category are able to understand problems well and plan solutions to solve problems appropriately. In contrast, students in the low-ability category simply record the existing data without understanding the correct way to solve the problem. Lack of precision in reading the questions leads to incomplete writing of the existing information, even though all subjects realize that the information provided is enough to solve the problem.

3. Step 3: Implement the Problem Solving Plan

In the problem-solving stage, students who reach this stage include M1, M2, M3, and M4, although they still experience errors in question number 3. On the other hand, M5 and M6 students still experience mistakes in questions 1, 2, and 3. Errors that occurred included incompetence in the calculation process, as well as inconsistencies in the results given with the results requested in the question. This finding is in line with the statement of Rigusti & Pujiastuti (2020), which emphasizes

the importance of reviewing the steps that have been taken in problem solving, because this plays a role in improving students' ability to solve problems.

Students with high ability categories can understand problems, plan solutions, and carry out solutions according to a well-made plan. In contrast, students with low ability categories can understand problems, but still have difficulty in planning strategies and performing the calculations necessary to solve problems appropriately.

4. Step 4: Double-Check

At the re-examination stage, no student reached this stage perfectly, because the research subjects still made mistakes in the stage of checking their answers. M1 made a mistake in questions 1 and 3, namely not carrying out the re-examination stage, while M2 and M3 made a mistake in question number 3. M4, M5, and M6 made mistakes in questions 1, 2, and 3. Mistakes made by the students include not writing down the conclusions of their work and not checking the answers that have been obtained.

The findings of this study indicate that students' mathematical problem-solving abilities differ according to their respective ability levels. These findings underscore the importance of a different learning approach for each skill group.

At the phase of comprehending the problem, students with low abilities experience a big obstacle due to a lack of basic understanding of ratios. This supports the findings of Hernaeny Ul'fah and Prastiwi (2021), who stated that the ability to understand problems is an important prerequisite for developing an effective strategy. For this reason, there is a need for a learning strategy that focuses on improving the ability to understand basic concepts.

Errors in planning problem solving and executing the solution plan are mostly caused by the inability of students to connect the information provided with relevant mathematical concepts. These results are consistent with the opinion of Suryani et al. (2020), which highlight the need for more intensive practice questions to help students develop the relationship between information and solutions.

In addition, the finding that students often visit the Re-examination stage shows a lack of habit to conduct a final evaluation. This is in line with the research of Fahira and Ramlah (2021), which stated that tahao re-checking is often overlooked although it is important to ensure that the solution provided is accurate. Strategies such as reflection-based learning can be applied to address this problem. This research also underscores the importance of student-centered approaches, such as the problem-based learning (PBL) learning model, which has been shown to improve problem-solving skills (Lestari & Rosdiana, 2018).

## CONCLUSION

The research findings on the mathematical problem-solving abilities of seventh-grade junior high school students reveal variations in their proficiency when applying Polya's problem-solving

steps. The results of the analysis showed that students with high abilities were able to understand the problem, plan, implement, and recheck the solution well. In contrast, students with low ability face difficulties at almost all stages of problem-solving, especially in understanding problems and planning solutions strategies.

Common mistakes among students, especially in the low ability category, are caused by a lack of understanding of the ratio material and an inability to organize relevant information. This indicates the need for a more effective teaching approach in mathematics learning, especially in developing problem-solving skills.

This research is expected to provide a clear picture of the level of students' problem-solving abilities and become a reference for educators to design better learning strategies. Thus, it is hoped that it can improve the mathematical ability of students in Indonesia, as well as facilitate the attainment of national education objectives to educate the nation's life through strengthening mathematics learning that focuses on problem solving.

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